CLAIMS

What is claimed is:

1. A pressure compensated core barrel apparatus, comprising:

an outer barrel assembly including a core bit secured to a lower end thereof and an opposing upper end configured for attachment to a drill string; and

an inner barrel assembly disposed within said outer barrel assembly and including a chamber, said inner barrel assembly configured to maintain fluid contained within said chamber at or below a specified pressure.

2. The pressure compensated core barrel apparatus of claim 1, further comprising a layer of sponge material disposed on at least a portion of an interior wall of said chamber, said sponge material adapted to absorb at least one specified reservoir fluid.

3. A piston assembly for providing a fluid seal within an inner barrel assembly of a core barrel apparatus, said inner barrel assembly including an interior wall, said piston assembly comprising:

a piston configured to provide a fluid seal between an outer cylindrical surface of said piston and said interior wall of said inner barrel assembly;

at least one laterally movable locking element associated with said piston, said at least one locking element configured to engage a cooperative structure of said interior wall of said inner barrel assembly when said at least one locking element is at a first position and to disengage said cooperative structure when said at least one locking element is at a second position; and

a slidable piston rod associated with said piston, said piston rod located and configured to maintain said at least one locking element at said first position when said piston rod is at one position, said piston rod further configured for travel relative to said piston to another position where said at least one locking element is free to move to said second position.

4. The piston assembly of claim 3, further comprising a disk-shaped portion on one end of said piston rod, said disk-shaped portion having a substantially planar surface located and oriented for contacting a core entering said inner barrel assembly.

5. The piston assembly of claim 3, further comprising a fluid passageway configured to extend from a first end of said piston to a second opposing end of said piston when said piston rod is at said another position.

6. The piston assembly of claim 5, wherein said fluid passageway comprises a bore extending through said piston rod and at least one port extending through said piston rod substantially transverse to said bore of said piston rod and in fluid communication therewith.

7. The piston assembly of claim 6, further comprising:

a disk-shaped portion on one end of said piston rod, said disk-shaped portion having a substantially planar surface located and oriented for contacting a core entering said inner barrel assembly; and

at least one port extending through said disk-shaped portion substantially transverse to said bore of said piston rod and in fluid communication therewith.

8. The piston assembly of claim 3, further comprising an O-ring type seal configured to provide said fluid seal between said outer cylindrical surface of said piston and said interior wall of said inner barrel assembly.

9. A pressure compensated inner barrel assembly for use in a core barrel apparatus, comprising:

an inner barrel assembly having an interior wall;

a sealing mechanism disposed at one end of said inner barrel assembly configured to provide a fluid seal between said sealing mechanism and said interior wall of said inner barrel assembly;

a pressure compensation mechanism disposed at an opposing end of said inner barrel assembly and configured to provide a fluid seal between said pressure compensation mechanism and said interior wall of said inner barrel assembly, a region within said interior wall of said inner barrel assembly between said sealing mechanism and said pressure compensation mechanism forming a chamber; and

a pressure relief element disposed on said pressure compensation mechanism configured to maintain fluid contained within said chamber at or below a specified pressure.

10. The pressure compensated inner barrel assembly of claim 9, wherein said pressure relief element comprises a pressure relief valve configured to release a controlled volume of fluid from said chamber when fluid pressure within said chamber exceeds said specified pressure.

11. The pressure compensated inner barrel assembly of claim 9, further comprising a thermal compensation mechanism coupled to said pressure compensation mechanism and configured to move said pressure compensation mechanism through said inner barrel assembly in response to a change in temperature to expand the volume of said chamber.

12. The pressure compensated inner barrel assembly of claim 11, wherein:

said pressure compensation mechanism comprises a cylindrical housing having said pressure relief element disposed thereon, said cylindrical housing configured to provide a movable fluid seal between an outer surface of said cylindrical housing and said interior wall of said inner barrel assembly; and

said thermal compensation mechanism comprises an adjusting sleeve slidably disposed in said inner barrel assembly, said adjusting sleeve having one end secured to said cylindrical housing of said pressure compensation mechanism and further including an opposing end configured to abut an end of a sponge liner disposed in said inner barrel assembly, said adjusting sleeve configured to move said cylindrical housing through said inner barrel assembly in response to thermal expansion of said sponge liner.

13. The pressure compensated inner barrel assembly of claim 9, wherein said sealing mechanism comprises:

a piston configured to provide a fluid seal between an outer cylindrical surface of said piston and said interior wall of said inner barrel assembly;

at least one laterally movable locking element associated with said piston, said at least one locking element configured to engage a cooperative structure of said interior wall of said inner barrel assembly when said at least one locking element is at a first position and to disengage said cooperative structure when said at least one locking element is at a second position; and

a slidable piston rod associated with said piston, said piston rod located and configured to maintain said at least one locking element at said first position when said piston rod is at one position, said piston rod further configured for travel relative to said piston to another position where said at least one locking element is free to move to said second position.

14. The pressure compensated inner barrel assembly of claim 13, wherein said sealing mechanism further comprises a fluid passageway configured to allow fluid within said chamber to flow from a first end of said piston facing said chamber to a second opposing end of said piston when said piston rod is at said another position.

15. A valve assembly for interconnecting a first inner tube section to a second inner tube section of a multi-section inner barrel assembly of a coring apparatus, said valve assembly comprising:

a lower seal assembly including a housing having a cylindrical bore extending therethrough, said housing further including a lower end configured for attachment to an upper end of said first inner tube section and an opposing upper end, said lower seal assembly further including a seal element disposed in said housing and configured to provide a fluid seal in said cylindrical bore; and

an upper seal assembly including a housing having a cylindrical bore extending therethrough, said housing of said upper seal assembly further including an upper end configured for

attachment to a lower end of said second inner tube section and an opposing lower end configured for attachment to said upper end of said housing of said lower seal assembly, said upper seal assembly further including a seal element disposed in said housing and configured to provide a fluid seal in said cylindrical bore of said housing of said upper seal assembly.

16. The valve assembly of claim 15, wherein said seal element of said lower seal assembly is selected from a group consisting of a substantially planar diaphragm, a dome-shaped diaphragm, a conically shaped diaphragm, a ball valve, and a releasable piston.

17. The valve assembly of claim 15, wherein said seal element of said upper seal assembly is selected from a group consisting of a substantially planar diaphragm, a dome-shaped diaphragm, a conically shaped diaphragm, a ball valve, and a releasable piston.

18. The valve assembly of claim 15, further comprising a tap disposed on one of said housing of said lower seal assembly and said housing of said upper seal assembly configured for introducing fluid into said cylindrical bore of said lower seal assembly and said cylindrical bore of said upper seal assembly.

19. A near-bit swivel assembly for supporting an inner barrel assembly within an outer barrel assembly of a coring apparatus, said outer barrel assembly having a core bit secured to a lower end thereof, said near-bit swivel assembly comprising:

a bearing assembly disposed at a lower end of said inner barrel assembly adjacent said core bit configured to radially position and orient said inner barrel assembly relative to a rotational axis of said outer barrel assembly and further configured to maintain said inner barrel assembly at a substantially fixed longitudinal position along said rotational axis of said outer barrel assembly; and

a latch mechanism disposed on one of an interior wall of said core bit and an interior wall of said inner barrel assembly configured, in cooperation with said bearing assembly, to maintain said inner barrel assembly at said substantially fixed longitudinal position;

wherein an opposing upper end of said inner barrel assembly is freely movable within said outer barrel assembly along said rotational axis thereof.

20. The near-bit swivel assembly of claim 19, wherein said bearing assembly comprises:

a radial bearing assembly including a journal secured to said lower end of said inner barrel assembly located and configured to slidably mate with a bushing secured to one of said interior wall of said core bit and said interior wall of said inner barrel assembly;

a thrust bearing assembly secured to said lower end of said inner barrel assembly including a thrust plate having a lower surface abutting a shoulder extending from one of said interior wall of said core bit and said interior wall of said inner barrel assembly and an opposing upper surface, said thrust bearing assembly further including a bearing plate having a lower surface located and configured to slidably mate with said upper surface of said thrust plate and an opposing upper surface disposed in close proximity to a register surface of said latch mechanism.

21. The near-bit swivel assembly of claim 19, wherein said latch mechanism comprises a retractable pawl secured to one of said interior wall of said core bit and said interior wall of said inner barrel assembly, said retractable pawl resiliently biased toward said rotational axis of said outer barrel assembly and located and configured to allow passage thereby of said lower end of said inner barrel assembly, said retractable pawl further including at least one register surface configured to engage a surface of said bearing assembly when said inner barrel assembly is fully inserted into said outer barrel assembly to maintain said inner barrel assembly at said substantially fixed longitudinal position.

22. A sponge liner for use in a sponge core barrel assembly, said sponge core barrel assembly including an inner barrel assembly formed of a first material and having a bore extending therethrough, said sponge liner comprising:

a tubular sleeve formed of a second material and having an outer cylindrical surface sized and configured to be slidably disposed in said bore of said inner barrel assembly, said tubular sleeve further including at least one groove formed in an inner cylindrical surface thereof, said at least one groove having a cross-sectional shape; and

an annular sponge layer formed of a material adapted to absorb at least one specified reservoir fluid, said annular sponge layer including an interior cavity and an outer cylindrical surface secured to said inner cylindrical surface of said tubular sleeve, said annular sponge layer extending into said at least one groove.

23. The sponge liner of claim 22, wherein said at least one groove comprises a groove configured in a helix about said inner cylindrical surface of said tubular sleeve, a groove extending longitudinally along said inner cylindrical surface of said tubular sleeve, or a groove extending circumferentially along said inner cylindrical surface of said tubular sleeve.

24. The sponge liner of claim 22, wherein said cross-sectional shape of said at least one groove is selected from a group consisting of a dove-tail shape, a generally circular shape, and a generally elliptical shape.

25. The sponge liner of claim 22, wherein said second material comprises a material identical to said first material or a material exhibiting a rate of thermal expansion substantially equivalent to a rate of thermal expansion of said first material.

26. The sponge liner of claim 22, further comprising a plurality of perforations extending through said tubular sleeve.

27. The sponge liner of claim 22, further comprising a shaped contour on at least one end of said sponge liner, said shaped contour configured to mate with a corresponding shaped contour on an end of a second, adjacent sponge liner, wherein said shaped contour on said sponge liner and said corresponding shaped contour on said second sponge liner are cooperatively configured to provide an interlocking end-to-end connection between said sponge liner and said second sponge liner.

28. The sponge liner of claim 27, wherein said shaped contour on said at least one end of said sponge liner and said corresponding shaped contour on said end of said second sponge liner are selected from a group consisting of a bevel contour, a generally parabolic contour, and a tongue-in-groove.

29. The sponge liner of claim 22, further comprising a layer of webbing material disposed in said annular sponge layer.

30. The sponge liner of claim 29, wherein said layer of webbing material is disposed in said annular sponge layer at a location proximate said interior cavity.

31. A sponge liner for use in a sponge core barrel assembly, said sponge core barrel assembly including an inner barrel assembly formed of a first material and having a bore extending therethrough, said sponge liner comprising:

a tubular sleeve formed of a second material and having an inner cylindrical surface and an outer cylindrical surface sized and configured to be slidably disposed in said bore of said inner barrel assembly, said second material exhibiting a rate of thermal expansion substantially equivalent to a rate of thermal expansion of said first material; and

an annular sponge layer formed of a material adapted to absorb at least one specified reservoir fluid, said annular sponge layer including an interior cavity and an outer cylindrical surface secured to said inner cylindrical surface of said tubular sleeve.

32. The sponge liner of claim 31, wherein said second material comprises a material identical to said first material.

33. A sponge liner for use in a sponge core barrel assembly, said sponge core barrel assembly including an inner barrel assembly having a bore extending therethrough, said sponge liner comprising:

a tubular sleeve having an inner cylindrical surface and an outer cylindrical surface sized and configured to be slidably disposed in said bore of said inner barrel assembly;

an annular sponge layer formed of a material adapted to absorb at least one specified reservoir fluid, said annular sponge layer including an interior cavity and an outer cylindrical surface secured to said inner cylindrical surface of said tubular sleeve; and

a layer of webbing material disposed in said annular sponge layer about at least a portion of a circumference of said annular sponge layer.

34. The sponge liner of claim 33, wherein said layer of webbing material is disposed in said annular sponge layer at a location proximate said interior cavity.

35. An integrated sponge barrel for use in a sponge core barrel apparatus, comprising:

at least one inner tube section having an inner cylindrical surface; and

an annular sponge layer constructed of a material adapted to absorb at least one specified reservoir fluid, said annular sponge layer including an interior cavity and an outer cylindrical surface secured to said inner cylindrical surface of said at least one inner tube section;

wherein said at least one inner tube section is sized and configured for direct disposition in an outer barrel assembly without a surrounding inner barrel.

36. The integrated sponge barrel of claim 35, further comprising at least one groove formed in said inner cylindrical surface of at least one inner tube section, said at least one groove having a cross-sectional shape, said annular sponge layer extending into said at least one groove.

37. The integrated sponge barrel of claim 36, wherein said at least one groove comprises a groove configured in a helix about said inner cylindrical surface of said at least one inner tube section, a groove extending longitudinally along said inner cylindrical surface of said at least one inner tube section, or a groove extending circumferentially along said inner cylindrical surface of said at least one inner tube section.

38. The integrated sponge barrel of claim 36, wherein said cross-sectional shape of said at least one groove is selected from a group consisting of a dove-tail shape, a generally circular shape, and a generally elliptical shape.

39. The integrated sponge barrel of claim 35, further comprising a plurality of perforations extending through said at least one inner tube section.

40. The sponge liner of claim 35, further comprising a layer of webbing material disposed in said annular sponge layer.

41. The sponge liner of claim 40, wherein said layer of webbing material is disposed in said annular sponge layer at a location proximate said interior cavity.

42. A method of providing a fluid seal in an inner barrel assembly of a core barrel apparatus, comprising:

providing a fluid seal between an interior wall of said inner barrel assembly and an outer cylindrical surface of a piston disposed in said inner barrel assembly;

abutting a surface of a slidable piston rod associated with said piston against a laterally movable locking element associated with said piston to bias said locking element against a cooperative structure of said interior wall of said inner barrel assembly to lock said piston at a fixed position within said inner barrel assembly; and

moving said piston rod relative to said piston in response to contact with a core sample to position said piston rod at a location allowing said locking element to move away from said cooperative structure to release said piston and enable said piston to travel freely within said inner barrel assembly.

43. The method of claim 42, further comprising providing a fluid passageway through at least one of said piston and said piston rod when said piston rod is at said location to enable fluid contained within said inner barrel assembly to flow out of said inner barrel assembly through said fluid passageway.

44. A method of supporting an inner barrel assembly within an outer barrel assembly of a core barrel apparatus, said outer barrel assembly having a core bit secured to a lower end thereof, comprising:

supporting a portion of said inner barrel assembly proximate a lower end thereof and adjacent said core bit to radially position and orient said inner barrel assembly relative to a rotational axis of said outer barrel assembly and to maintain said inner barrel assembly at a substantially fixed longitudinal position along said rotational axis of said outer barrel assembly; and

allowing an opposing upper end of said inner barrel assembly to freely move longitudinally within said outer barrel assembly along said rotational axis thereof.

45. A method of securing a layer of sponge material to an interior of a tubular structure, comprising:

forming at least one groove in an interior cylindrical surface of said tubular structure; and

extending said layer of sponge material into said at least one groove in said interior cylindrical surface.

46. The method of claim 45, wherein extending said layer of sponge material into said at least one groove comprises molding said layer of sponge material into said at least one groove.

47. A method of constructing an inner barrel assembly for a sponge core barrel apparatus comprising securing a layer of sponge material adapted to absorb at least one specified reservoir fluid directly to an interior cylindrical surface of said inner barrel assembly.

48. A method of eliminating differential thermal expansion between an inner barrel assembly of a sponge core barrel apparatus and at least one sponge liner disposed in said inner barrel assembly, said at least one sponge liner including a layer of sponge material secured to an interior cylindrical surface of a tubular sleeve, comprising:
constructing said inner barrel assembly of a first material; and
constructing said tubular sleeve of said at least one sponge liner from a second material exhibiting a rate of thermal expansion substantially equivalent to a rate of thermal expansion of said first material.

49. The method of claim 48, further comprising constructing said tubular sleeve of a material that is identical to said first material.

50. A method of reducing friction between a core sample and an interior wall of an inner barrel, at least a portion of said interior wall comprising a layer of sponge material adapted to absorb at least one specified reservoir fluid, said method comprising disposing a layer of webbing material in said layer of sponge material to strengthen said layer of sponge material.

51. The method of claim 50, further comprising disposing said layer of webbing material in said layer of sponge material at a location proximate an interior chamber of said inner barrel.